

REMARKS

The Official Action dated February 12, 2004 has been carefully considered.

Accordingly, the changes presented herewith, taken with the following remarks, are believed sufficient to place the present application in condition for allowance.

By the present amendment, claim 1 has been amended to include the limitations from claims 5 and 6, while claim 7 has been amended to include the limitations from claims 11 and 12. These claims have also been amended to further include limitations from the specification for example at page 16, line 26 to page 19, line 12 of the specification, and to provide antecedent basis for the term "quaternary ammonium salt (B)" in claims 3 and 9. Since these changes do not involve any introduction of new matter, entry is believed to be in order and is respectfully requested.

In the Official Action, the Examiner referred to documents cited in the International Search Report of the PCT International Stage Application. Applicants note that the Information Disclosure Statement filed by certificate of mailing on April 12, 2002 and received by the U.S. Patent and Trademark Office on April 18, 2002 made all of the references from the International Search Report of the PCT International Stage Application of record in the present application.

In the Official Action, claims 1-16 were rejected under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being obvious over JP 7-003100 (JP '100). The Examiner asserted that the English abstract of this reference specifically or inherently meets each of the claimed limitations and that any selection of a particular type of carbon black or resultant molded product would be within the purview of the skilled artisan.

However, as will be set forth in detail below, the semiconductive polyvinylidene fluoride resin compositions and the formed or molded products defined by the present claims 1-4, 7-10 and 13-16 are neither anticipated by nor rendered obvious over, and are patentably distinguishable from, JP '100. Accordingly, this rejection is traversed and reconsideration is respectfully requested.

More particularly, as defined by claim 1, the semiconductive polyvinylidene fluoride resin compositions according to the present invention comprise 100 parts by weight of a polyvinylidene fluoride resin (A), 0.03 to 10 parts by weight of at least one quaternary ammonium salt (B), and 2 to 15 parts by weight of at least one conductive carbon black (C). The quaternary ammonium salt (B) is at least one compound selected from the group consisting of tetraalkylammonium sulfates (B1) represented by the formula (1) and tetraalkylammonium sulfites (B2) represented by the formula (2). The conductive carbon black (C) is at least one conductive carbon black selected from the group consisting of acetylene black and conductive oil furnace black. The conductive carbon black has DBP oil absorption of at least 100 ml/100 g. The semiconductive polyvinylidene fluoride resin composition has a volume resistivity within a range of 10^4 to 10^{12} Ωcm . As defined by claim 7, the formed or molded products according to the invention are composed of the above semiconductive polyvinylidene fluoride resin compositions.

The semiconductive polyvinylidene fluoride resin compositions according to the present invention stably and uniformly exhibit a fixed volume resistivity within a range of 10^4 to 10^{12} Ωcm with good precision and undergo extremely little change in volume resistivity and surface resistivity, even under varying environmental moisture conditions.

Advantageously, the semiconductive polyvinylidene fluoride resin compositions can be used to obtain semiconductive formed or molded products. As is apparent from the results shown

in Table 1 of the present specification, the semiconductive polyvinylidene fluoride resin compositions of Examples 1-10 according to the present invention are moderately low in volume resistivity and exhibit a narrow range of volume resistivity with location, i.e., the difference between the maximum and minimum volume resistivities is relatively small. Further, the exemplary semiconductive polyvinylidene fluoride resin compositions do not exhibit neither aggregates, fish eyes, or bleed-out of additives.

From the English Abstract, JP '100 discloses a fluororubber composition comprising (A) 100 parts by weight of a fluororubber produced by copolymerization between vinylidene fluoride and hexafluoropropylene or between vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene, (B) 0.05-2 parts by weight of an organic quaternary phosphonium salt, (C) 0.05-2 parts by weight of an organic quaternary ammonium hydrogensulfate and/or a salt derived from 1,8-diazabicyclo [5.4.0]-7-undecene, (D) 0.1-10 parts by weight of a polyhydroxy compound, and (E) 0.5-30 parts by weight of a metal oxide and or metal hydroxide.

Applicants advise that JP '100 further discloses the use of tetrabutylammonium hydrogensulfate as an organic quaternary ammonium hydrogensulfate and a copolymer of vinylidene fluoride and hexafluoropropylene (60/40 weight ratio) as a fluororubber in Example 1, and that a fluororubber composition was obtained by blending 100 parts of the fluororubber, 30 parts of MT carbon, 1.5 parts of bisphenol AF, 0.2 parts of triphenylbenzylphosphonium chloride, 0.2 parts of tetrabutylammonium hydrogensulfate, 3 parts of magnesium oxide, and 6 parts of calcium hydroxide on 2-roll in Example 1.

However, Applicants find no teaching or suggestion in JP '100 relating to a polyvinylidene fluoride resin composition having a volume resistivity within a range of 10^4 to 10^{12} Ωcm , nor do the compositions disclosed by JP 7-003100 necessarily have such a

resistivity. That is, the MT carbon disclosed by JP '100 is not a conductive carbon black, but rather is a known reinforcing thermal grade carbon black. Reinforcing thermal grade carbon blacks such as MT black are generally produced from natural gas in preheated chambers without air. They are inactive, improve the tensile strength of the vulcanizates very little, but give only moderate hardness at high loading, and good processing and dynamic properties. Thermal blacks are particles having very large diameter and contain little aggregated structures between particles. Thus, thermal grade carbon black has an undeveloped structure.

The amount of DBP oil absorption is an indication of a carbon black's structure. MT black has an average diameter of 450-556 nm and 0.3-0.5 cc/g (i.e., 30-50 ml/100g) of DBP oil absorption as evidenced by attached Exhibit A which is a copy of a portion of a reference, *Compounding Ingredients for Rubber and Plastics*, page 230 (1993). Section (III) on page 230 of the reference teaches that MT black has an average diameter of 450-556 nm and 0.3-0.5 cc/g of DBP oil absorption. Carbon black having low DBP oil absorption has an undeveloped structure and exhibits extremely low electrical conductivity. Therefore, reinforcing thermal grade carbon blacks such as MT carbon have an undeveloped structure and exhibit extremely low electric conductivity. Accordingly, it is apparent that the fluororubber composition of JP '100 comprising MT carbon are insulating materials and do not have a volume resistivity within a semiconductive range.

On the other hand, conductive carbon black as required in the presently claimed compositions has a developed structure. When conductive carbon black makes conductive-networks, electrons flow through the carbon black-containing polymer composition. When aggregates of carbon black particles contact or approach each other, electrons flow from one aggregate to other aggregate in insulating polymer matrix. As recited in claims 1 and 7, the

conductive carbon black has a DBP oil absorption of at least 100 ml/100 g and the semiconductor resin composition has a volume resistivity within a range of 10^4 to 10^{12} Ωcm .

Second, the vinylidene fluoride copolymer disclosed by JP 7-003100 is an amorphous *elastomer* (hence the name of a fluororubber) rather than a polyvinylidene fluoride *resin* as required in the present claims.

Although the glass transition temperature (T_g) of the polyvinylidene fluoride (PVDF) resin of the present invention can be as low as -42°C , the PVDF resin of the claimed compositions and products is not an elastomer but rather a crystalline polymer. As well known in the art, PVDF resin is a specific polymer taking 4 crystal structures of α type, β type, α' type and γ type according to crystallization conditions. On the other hand, to obtain an amorphous elastomer, wherein vinylidene fluoride (VDF) is copolymerized with a fluorine-containing comonomer copolymerizable therewith, it is necessary to destroy the crystal structure by introducing at least a predetermined amount of comonomer units. For example, JP '100 discloses, as a fluororubber, vinylidene fluoride/hexafluoropropylene copolymers in which the monomers are combined in a weight ratio of 40/60-80/20 (paragraph 0006). In order to impart well balanced physical properties of an elastomer (fluororubber) to the copolymer of vinylidene fluoride (VDF) and hexafluoropropylene (HFP), it is actually necessary to introduce HFP units in a proportion of at least about 20%. Therefore, in commercially available VDF/HFP elastomer, at least about 20% of HFP units are introduced. In Example 1 of JP '100, a copolymer relatively high in HFP units (a VDF/HFP 60/40 wt. ratio) is used as a fluororubber. In contradistinction to the rubbers of JP '100, the polyvinylidene fluoride resin used in the present invention is a crystalline polymer at ordinary temperature and is not an amorphous elastomer.

The Examiner's attention is further directed to attached Exhibit B which is a copy of *Fluororesin Handbook*, edited by T. Satokawa, pp 556-558 (1990). An English translation of Section 1.2.2 of the reference is also included. Section 1.2.2 of this reference teaches that, with respect to a vinylidene fluoride/hexafluoropropylene copolymer (VDF-HFP bipolymer) and a vinylidene fluoride/hexafluoropropylene/tetrafluoroethylene copolymer rubber (VDF-HFP-TEF terpolymer), it is necessary to introduce hexafluoropropylene units in at least a fixed amount for the purpose of breaking crystals to provide an amorphous rubber (i.e., a fluororubber), since the vinylidene fluoride unit is easy to undergo crystallization. This document discloses that at least about 20 mol% hexafluoropropylene units need to be added to the fluororubber to provide a fluororubber having good rubber elasticity.

From above references, a person skilled in the art would have recognized that the fluororubber used in JP '100 is an amorphous fluoroelastomer, and not a polyvinylidene fluoride resin as required in the present claims.

Finally, in the composition of JP '100, since an organic quaternary ammonium hydrogensulfate such as tetrabutylammonium hydrogensulfate is used as a crosslinking accelerator, it chemically reacts with the fluororubber and ingredients. On the other hand, in the resin according to the present invention, since the crystalline polyvinylidene fluoride resin has a low T_g, and the resin itself has a polarity by the influence of a highly electronegative fluorine atom, the highly electronegative quaternary ammonium salt likewise interacts with the polyvinylidene fluoride resin to dissociate. An ion formed by dissociation of the quaternary ammonium salt is transferred by micro-Brownian motion of the polyvinylidene fluoride resin, and moderate semiconductivity is achieved.

The combined use of the quaternary ammonium salt (B) and the conductive carbon black (C) can bring about the following marked action and effects:

(1) the volume resistivity of the resin composition can be controlled within a range of generally 10^4 to 10^{12} Ωcm , preferably 10^5 to 10^{10} Ωcm ;

(2) a scatter of volume resistivity with location is less compared with the case where the conductive carbon black is used by itself, and the desired volume resistivity can be stably developed with good precision;

(3) since good semiconductivity is exhibited even when the proportion of the quaternary ammonium salt blended is low, the formation of aggregates and fish eyes caused by ionic electrolytes is prevented, and no bleed-out of ingredients occurs; and

(4) since proportions of these additives blended may be controlled to relatively low levels, the various properties inherent in the polyvinylidene fluoride resin, such as heat resistance, chemical resistance, anti-adhesion properties and stain resistance, can be retained, and the molding and processing ability of the resulting resin composition is also good.

Anticipation under 35 U.S.C. §102 requires that each and every element as set forth in the claims is found, either expressly or inherently described, in a single prior art reference, *In re Robertson*, 49 U.S.P.Q. 2d 1949, 1950 (Fed. Cir. 1999). In view of the failure of JP '100 to teach or suggest compositions containing conductive carbon black as required by the present claims, polyvinylidene fluoride resin as required by the present claims, and compositions exhibiting volume resistivity as presently claimed, JP '100 does not set forth, either expressly or inherently, each and every element as presently claimed and therefore does not anticipate the present claims under 35 U.S.C. §102.

Moreover, in order to render a claimed invention obvious, the prior art must enable one skilled in the art to make and use the claimed invention, *Motorola, Inc. v. Interdigital Tech. Corp.*, 43 U.S.P.Q. 2d 1481, 1489 (Fed. Cir. 1997). In view of the noted deficiencies in the teachings of JP '100, this reference does not enable one of ordinary skill in the art to

make and use semiconductive polyvinylidene fluoride resin compositions as presently claimed. Thus, JP '100 does not render the presently claimed compositions and formed or molded products obvious under 35 U.S.C. §103.

It is therefore respectfully submitted that the semiconductive polyvinylidene fluoride resin compositions defined by claims 1-4 and the products using the semiconductive polyvinylidene fluoride resin compositions, defined by 7-10 and 13-16 are neither anticipated by nor rendered obvious over JP '100, whereby the rejection has been overcome. Reconsideration is respectfully requested.

Claims 1-16 were rejected under 35 U.S.C. §103(a) as being obvious and unpatentable over European reference EP 333 062 (EP '062). The Examiner asserted that EP '062 discloses compositions comprising a fluoroelastomer of vinylidene fluoride units and 0.2-4 parts by weight, per hundred parts by weight fluoroelastomer, of a crosslinking accelerator which is a quaternary ammonium salt of the formula $R''_4N^+X^-$ wherein each R'' is independently an alkyl group of 2 to 10 carbon atoms or an aralkyl group of 7-10 carbon atoms and X⁻ is selected from a group including hydrogen sulfate. The Examiner asserted that when a filler is employed, it is added in amounts up to about 100 parts and representative fillers include reinforcing thermal grade carbon blacks or non-black pigments of relatively low reinforcement characteristics such as clays. The Examiner asserted that the broad range of up to about 100 parts overlaps the claimed range of 1 to 20 parts.

However, Applicants submit that the compositions and products defined by claims 1-4, 7-10 and 13-16 are nonobvious over and patentably distinguishable from the teachings of EP '062. Accordingly, this rejection is traversed and reconsideration is respectfully requested.

The semiconductive polyvinylidene fluoride resin compositions and formed or molded products defined by the present claims are discussed in detail above as are the improvements exhibited thereby.

EP '062 discloses the use of carbon black comprising MT as a reinforcing thermal grade carbon black in the Examples (see TABLES 1-6). As described above, MT carbon is not a conductive carbon black, but rather a reinforcing thermal grade carbon black. The reinforcing thermal grade carbon blacks such as MT carbon black have DBP oil absorption of far below 100 ml/100 g, and do not provide a semiconductive composition as presently claimed. EP '062 also discloses, as preferable fluoroelastomers, vinylidene fluoride/hexafluoropropylene copolymers in which the monomers are combined in a molar ratio of about 88:12 to 50:50 (column 2, lines 57-67). In order to obtain the elastomer, it is necessary to introduce hexafluoropropylene units in a proportion of at least 12%. However, as also discussed above, in order to impart physical properties well balanced as an elastomer to the copolymer of vinylidene fluoride (VDF) and hexafluoropropylene (HFP), it is actually necessary to introduce HFP units in a proportion of at least about 20%. One of ordinary skill in the art would therefore have recognized that the fluoroelastomer used in EP '062 is an amorphous fluoroelastomer, and not a polyvinylidene fluoride resin as presently claimed that is a crystalline polymer.

In the composition of EP '062, a quaternary ammonium salt of the formula $R''_4N^+X^-$ such as tetrabutylammonium hydrogen sulfate $[(C_4H_9)_4NHSO_4]$ is used as a crosslinking accelerator. As a result, the salt chemically reacts with the fluoroelastomer, a bisphenol or a polyhydroxyphenol crosslinking agent. In contrast, as discussed above, the salt in the present compositions dissociates and contributes to the improved semiconductive properties of the compositions.

In view of the failure of EP '062 to teach or suggest compositions containing a conductive carbon black as presently claimed, a polyvinylidene fluoride resin and a salt which is allowed to disassociate, as presently claimed, EP '062 fails to provide an enabling disclosure of the presently claimed compositions and products. Thus, EP '062 fails to render the presently claimed compositions and products obvious.

It is therefore respectfully submitted that the semiconductive polyvinylidene fluoride resin compositions defined by claims 1-4 and the products using the semiconductive polyvinylidene fluoride resin compositions, as defined by 7-10 and 13-16 are nonobvious over EP '062, whereby the rejection has been overcome. Reconsideration is respectfully requested.

It is believed that the above represents a complete response to the rejections set forth in the Official Action and places the application in condition for allowance. Reconsideration and an early allowance are requested.

Respectfully submitted,

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